New Sensor Technology: Air Monitoring for Fuel & Naphthalene- Related Risk Management

Opinions expressed are my own and do not necessarily reflect the policy of the Army Corps of Engineers, the Army or DOD.

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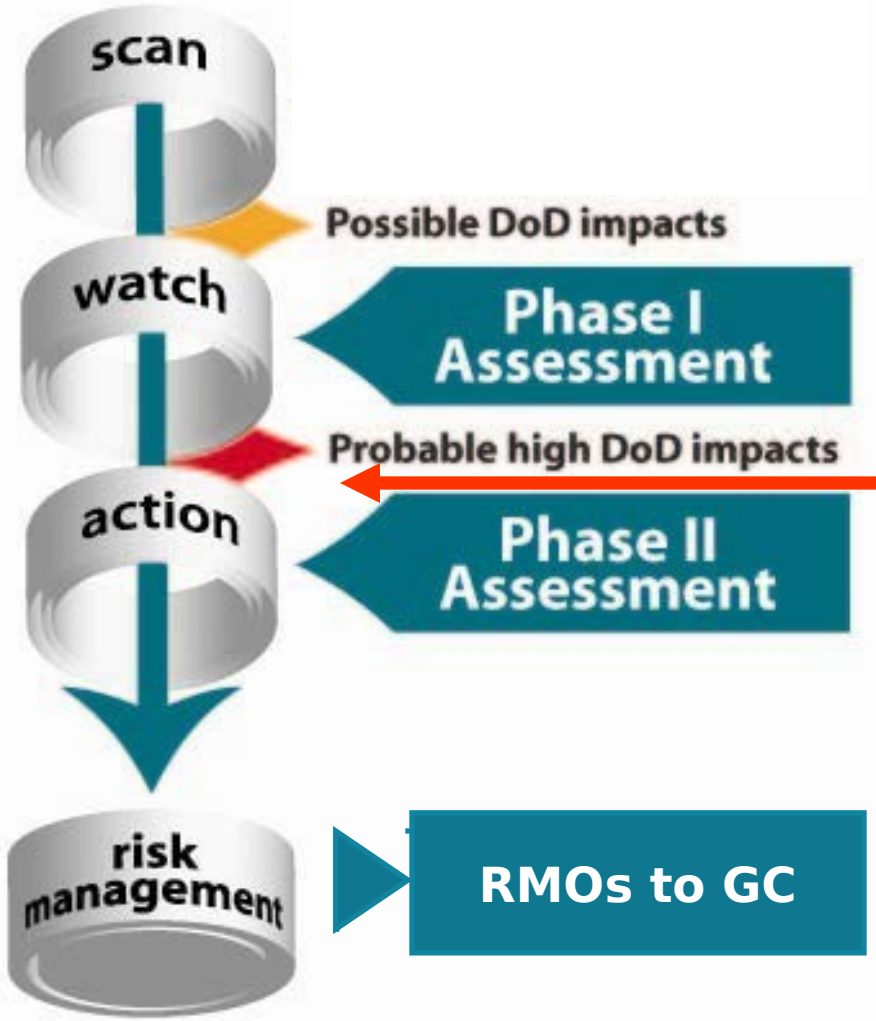
Topics To Be Presented

- **The Naphthalene Impact Assessments**
  - Scan-Watch-Action
- **The Naphthalene Dosimeter SBIR Project**
  - Application of sensor technology to develop a real-time exposure monitor
- **The Naphthalene Dosimeter Validation Project**
  - Part 1: Independent validation of the prototype's performance
  - Part 2: Transform the exposure monitor into a *dosimeter*

Topic #1
The Naphthalene Impact Assessments

Here is Why Naphthalene's on the "Action List"



Source: CMRM Directorate

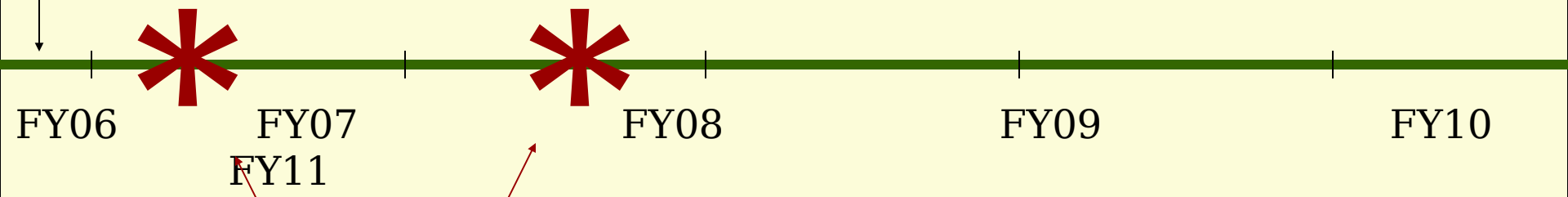
Cal OSHA: Newly recommended OEL is 13x lower & based on non-cancer endpoint

EPA: Naphthalene may be reclassified as "likely" human carcinogen (NTP Results).

29CFR 1910.1200: If carcinogen content greater than 0.1%, the substance is considered a carcinogenic hazard.

Naphthalenes are a 1-3 % component of JP8 and DOD's annual JP8 consumption approximately 5 billion gallons.

Naphthalene State of the Science Meeting, 10/06



Naphthalene Phase I Impact Assessments (Noblis & CTC)

Naphthalene Phase II Impact

How the Information Flows

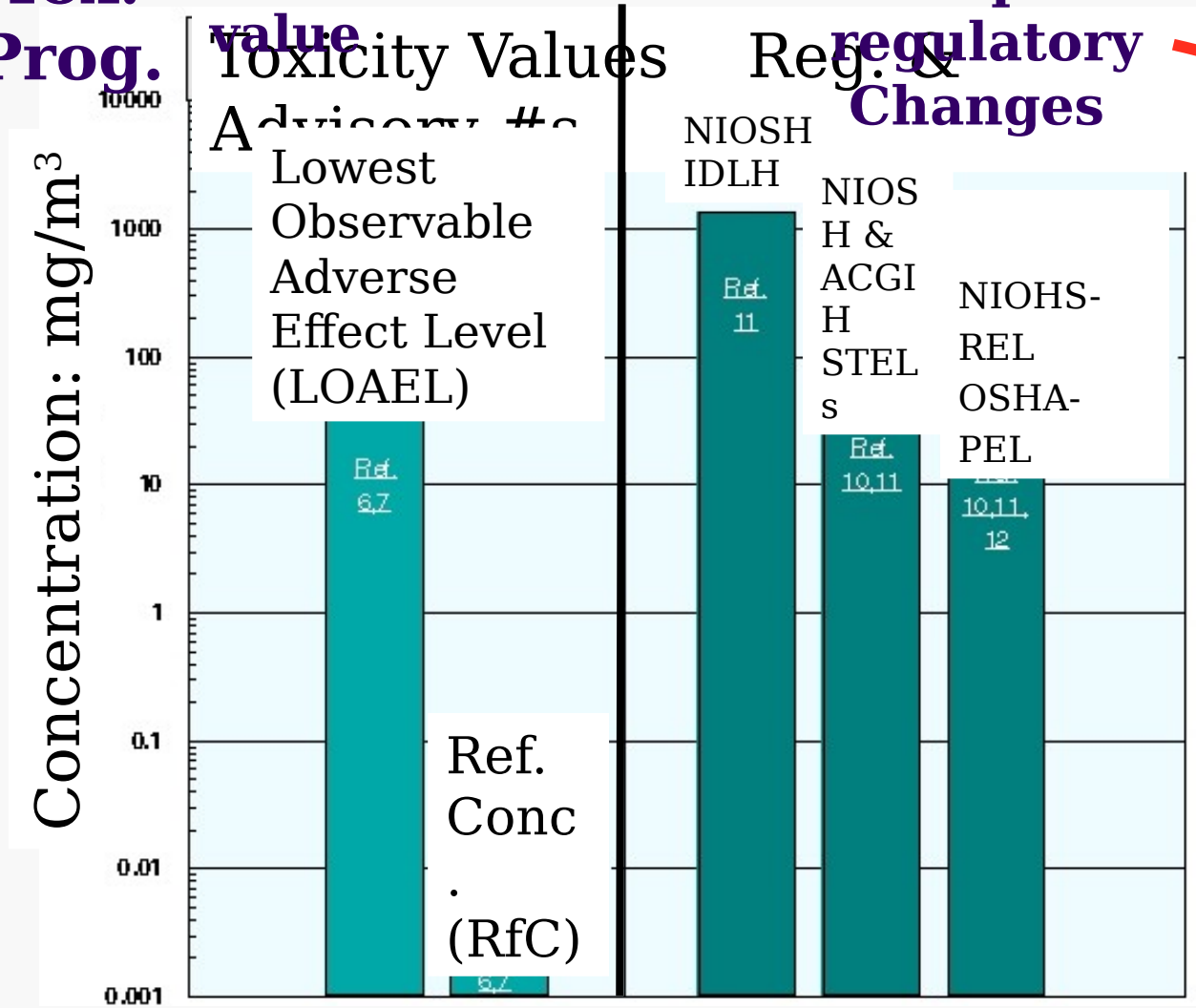
Nat'l Tox. Prog.

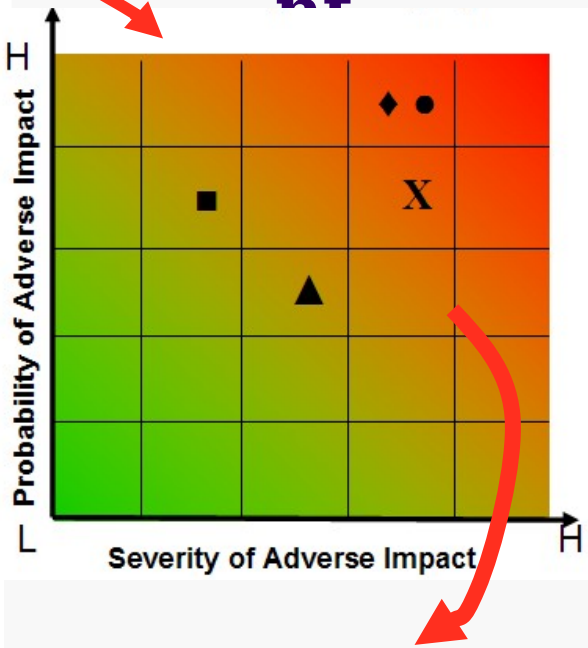
EPA drafts Cancer Tox. value

DOD anticipates regulatory Changes

Phase I impact assessme

Toxicity Values Reg. &
Advisory #s



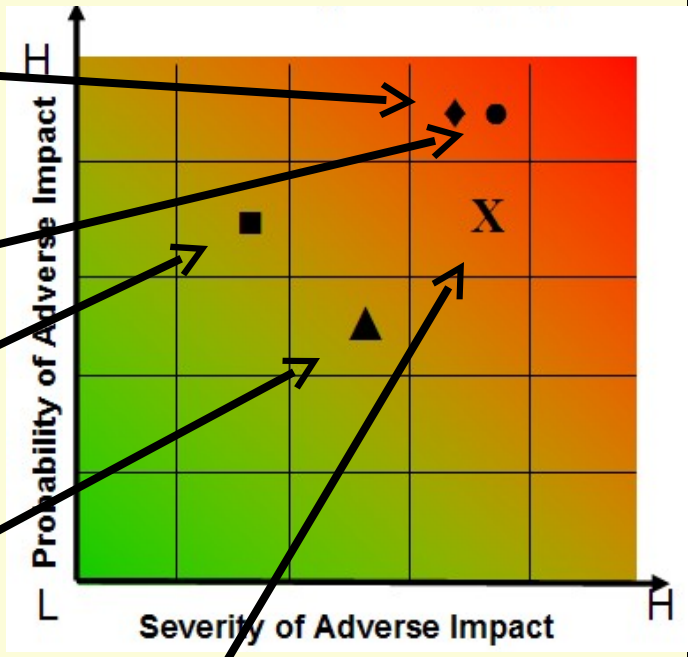


The DOD does a more rigorous Phase II impact assessment &

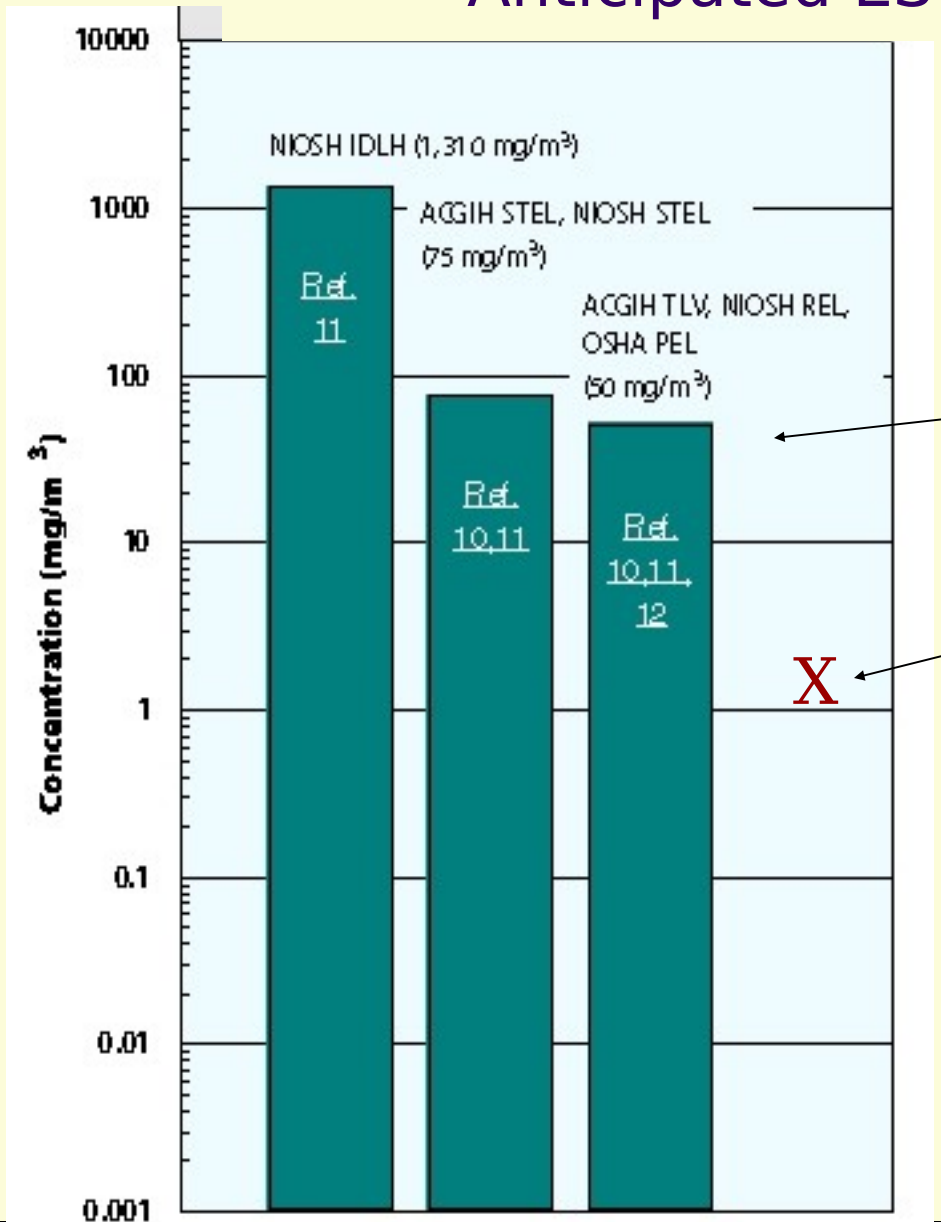
Source:

New Naphthalene Regulation? Anticipated Impacts to DOD functions

- Occupational Health
  - Fuel related exposures
- Production, Operations, Maint. & Disposal of Assets
  - Newly identified air pollution
- Readiness & Training
  - Increased fuel costs
- Acquisitions -RDT&E
- Environmental Restoration
  - Cleanup of sites w/ fuel…newly identified cancer risk & increase in Cost-to-Complete



Evolving Occupational Regulation: Anticipated ESOH impact



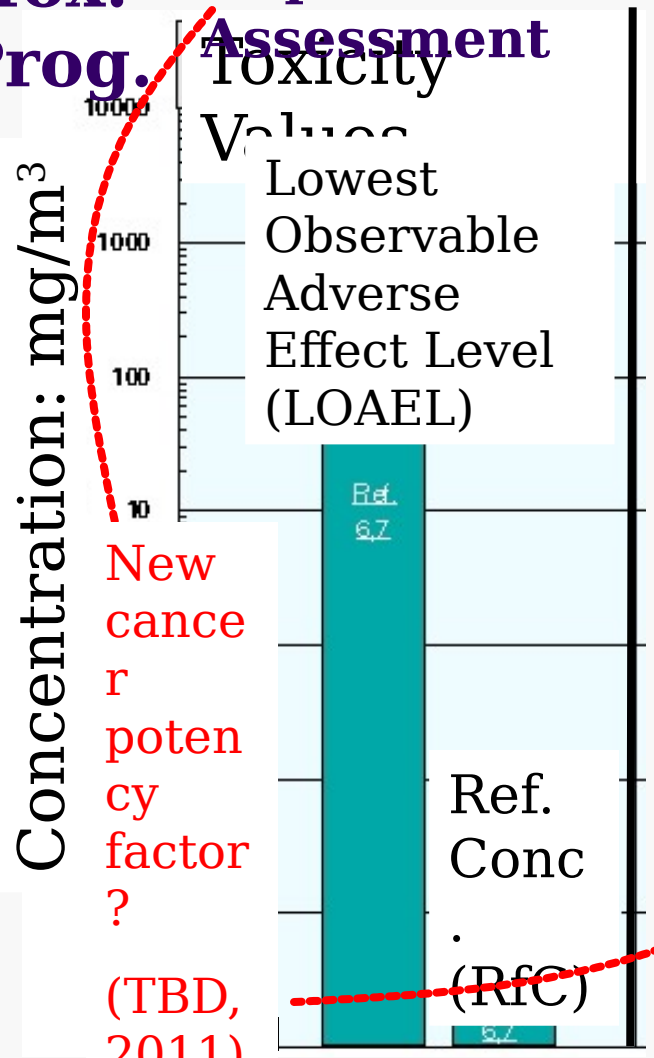
PEL, 50 mg/m³

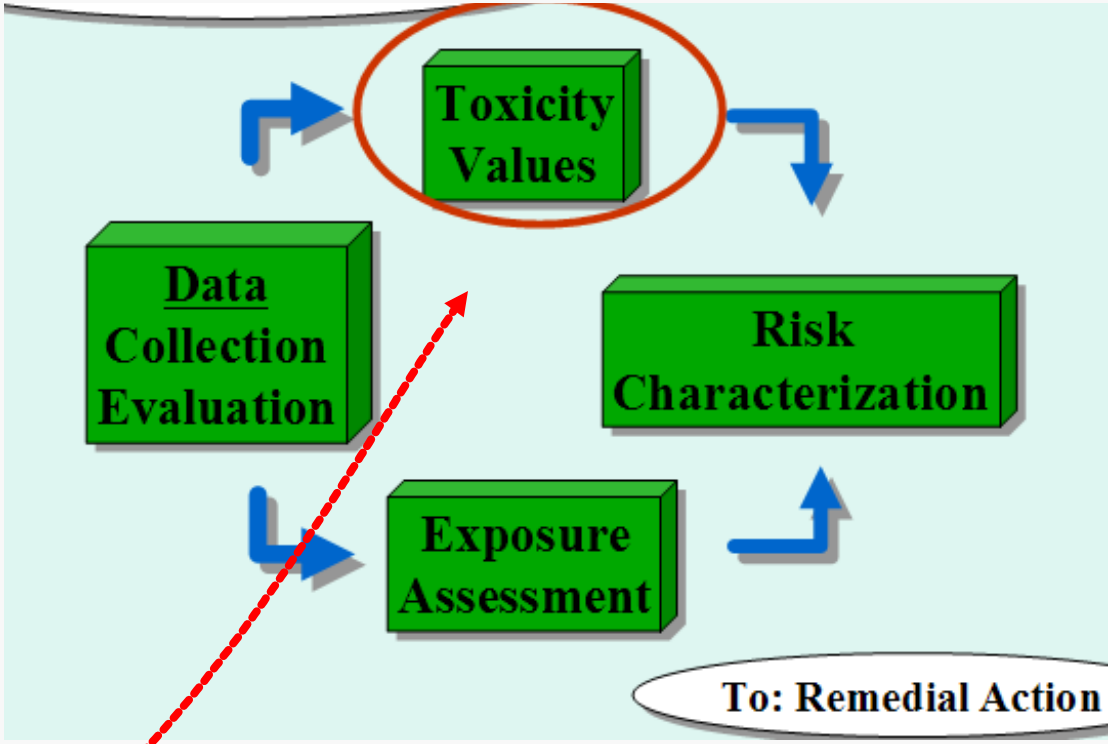
Cal-OSHA's recommended OEL is 3.9 mg/m³

Anticipated Cleanup Program Impact

Nat'l Tox. Prog.

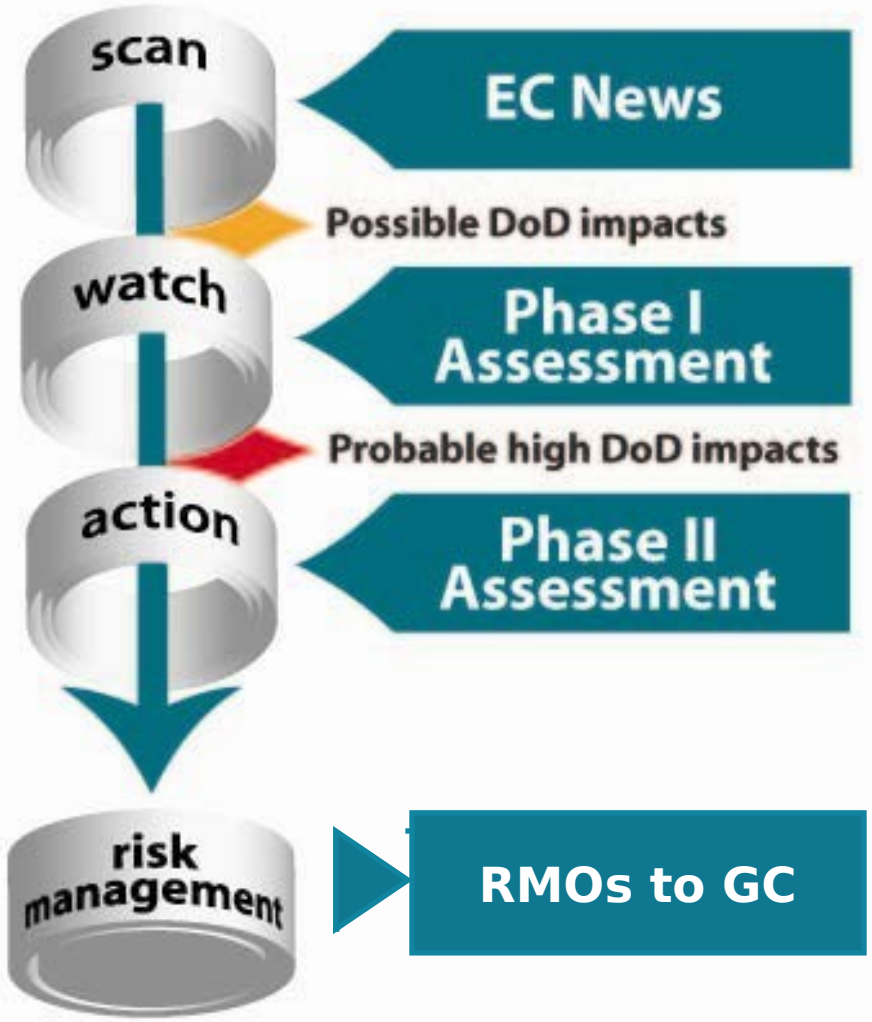
EPA drafts Naphthalene Risk Assessment





Source:

Naphthalene Phase II Assessment



QUANTITATIVE Impact Assessment

Objectives:

1)risk management options

2)strategic investment options

Source: CMRM Directorate

Topic #2
The Naphthalene Dosimeter SBIR Project

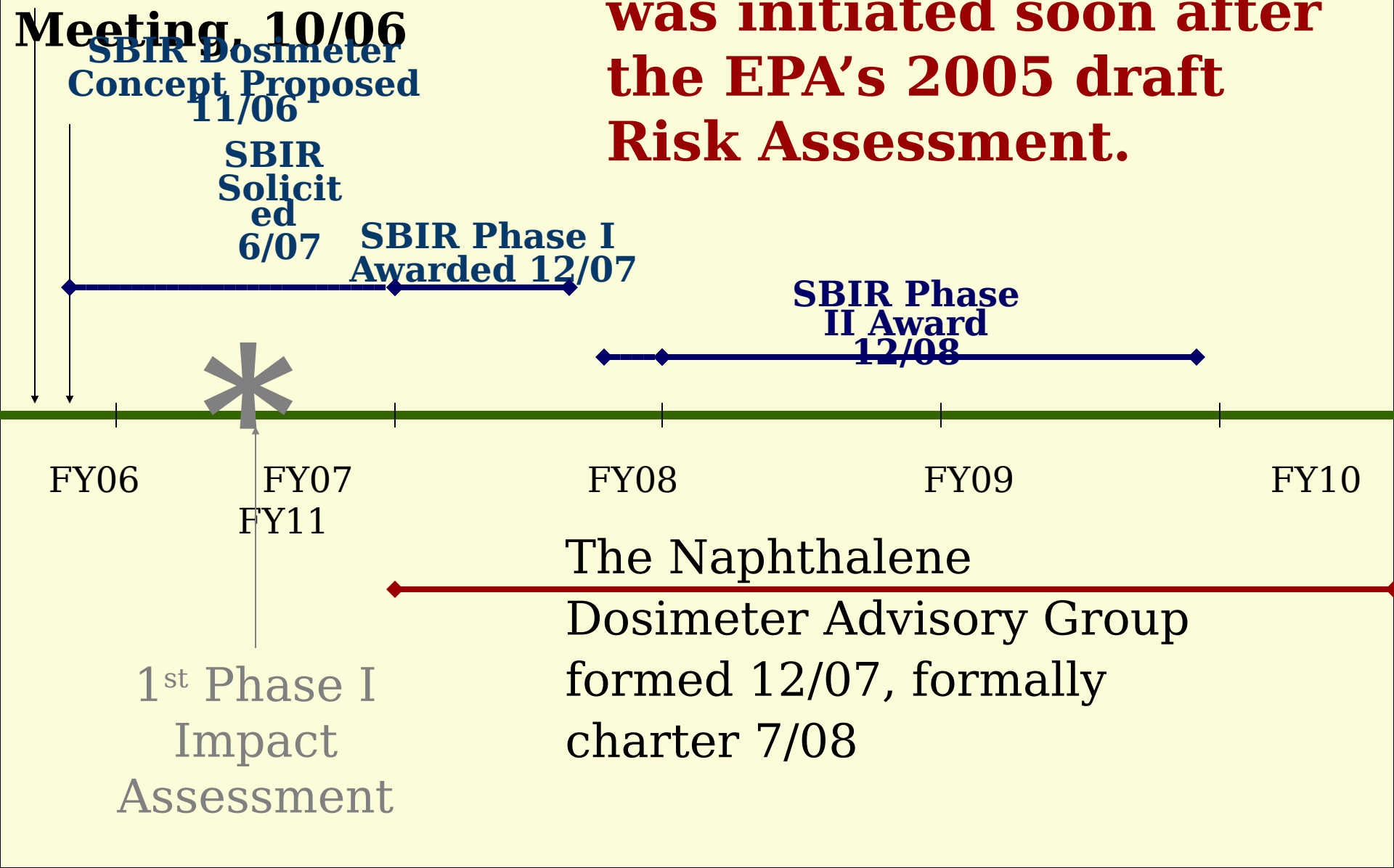
Dosimeter SBIR Project Goal

- **Develop a naphthalene dosimeter as a tool to manage naphthalene-related health risks.**

- **Apply new sensor technology to develop a real-time naphthalene dosimeter.**
  - naphthalene-specific and quantitative
  - detection concentrations as low as 0.1 mg/m^3
  - audible alert signal at Immediate Danger to Life/Health
  - electronic logging of exposure over time, e.g., work shift
  - cell phone size
  - durable in cold, hot, humid and dusty environments

Naphthalene State of the Science Meeting, 10/06

The dosimeter project was initiated soon after the EPA's 2005 draft Risk Assessment.



The Naphthalene Dosimeter Advisory Group-

Janis Hulla, PhD, DABT (Chair) Senior Toxicologist, Sacramento Dist. U.S. Army Corps of Engineers	
Micheline Strand, PhD (Co-Chair) Life Sciences Division Chief U.S. Army Research Office	**LTC Jonathan Thomas, (Co-Chair) USAF, BSC, PhD, PE, CIH ODUSD (I&E)**
David R. Mattie, PhD, DABT Research Toxicologist	**CDR Gail D. Chapman, Ph.D., MBA OIC/NHRC DET EHE Lab**
Yvonne Walker, MSE, MS, CIH Director, Environmental Programs Navy & Marine Corps Public Health	**Susan P. Proctor, DSc Research Epidemiologist US Army Research Inst. of Enviro. Med.**
Katharine Kurtz, Toxicologist Navy and Marine Corps Public Health	**John P. Hinz, Toxicologist USAFSAM - Environmental Toxicology**
Charles A. Kubwabo, Director	**John Gambre**

The Naphthalene Dosimeter SBIR Project

- **Funded by the Army Research Office**
  - 2 SBIR Phase I contracts award in FY08, $75,000 each
  - 1 Phase II contract awarded for FY09-10, $750,000
- **The SBIR Phase II Contractor**
  - Photon Systems, Covina, CA, William Hug, PhD, CEO.
- **Army Research Office Project Manager**
  - Micheline Strand, PhD (Army Research Office)
- **Project Science Manager**
  - Janis Hulla, PhD, DABT (USACE-SPK)
    - » funded by ARO and USACE's FUDS & EMCX

Exposure to Petroleum-Based Fuels

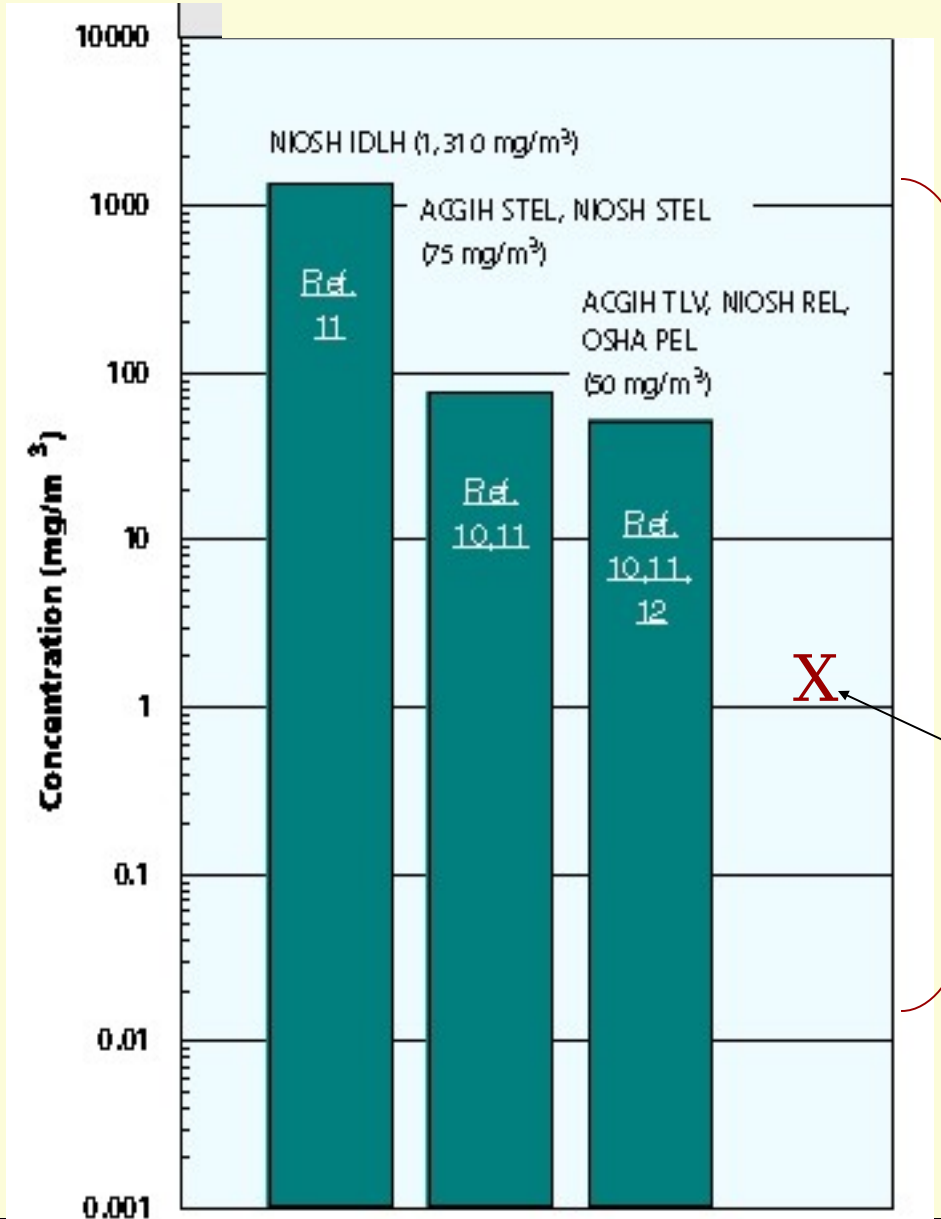
The single largest chemical exposure war fighters experience.

Risk Management Options

- RDT&E
- Material substitution
- Process changes
- Regulatory engagement
- Stockpile material
- Exposure assessment & monitoring
- Personal Protective Equipment (PPE)
- Acquisition changes
- Benchmark with industry
- Risk communication
- Training

Naphthalene Dosimeter SBIR Project

Current Naphthalene Reg./Advisory Levels



1,310 mg/m³ IDLH

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50 mg/m³ PEL

.

Range targeted for the Naphthalene Dosimeter capability

.

Cal- OSHA's recommended OEL is 3.9 mg/m³.

Development of the Naphthalene Dosimeter

DODs' Concept: Fuel Handling Deployments

Assessing Performance of the Prototypes

Exposure Chamber Experiments

Photon Systems Inc. uses:

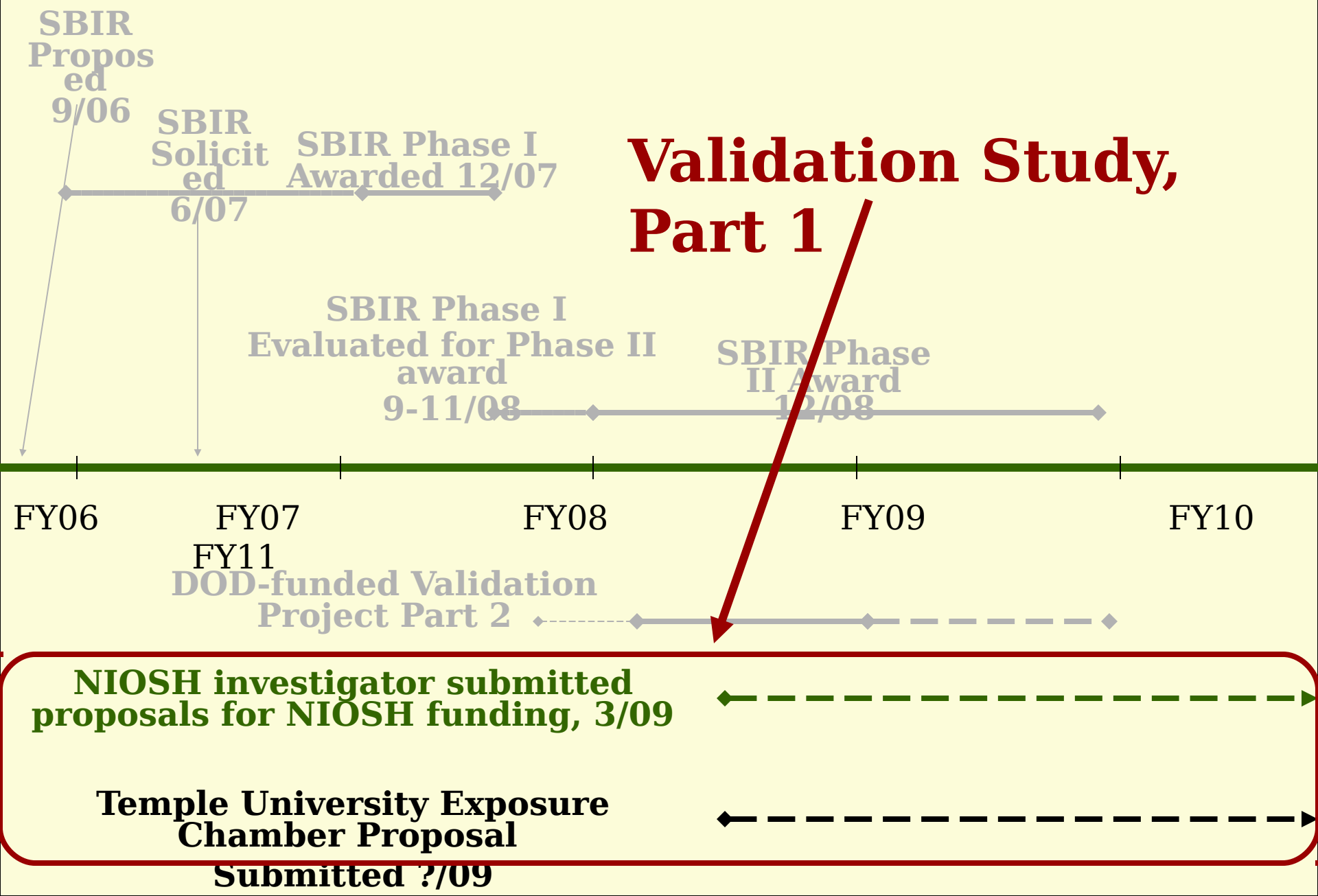
- Hot/Cold finger for introduction of known vapor pressure of jet fuel, Naphthalene, & maybe other fuel components
- Deep UV absorption spectrometer inside

Topic #3

The Naphthalene Dosimeter Validation

Part 1
Independently validate the performance

Part 2
Transform a prototype exposure monitor into a dosimeter


SBIR Proposed 9/06
SBIR Solicited 6/07
SBIR Phase I Awarded 12/07
Validation Study, Part 1
SBIR Phase I Evaluated for Phase II award 9-11/08
SBIR Phase II Award 12/08
FY06
FY07
FY08
FY09
FY10
FY11
DOD-funded Validation Project Part 2
NIOSH investigator submitted proposals for NIOSH funding, 3/09
Temple University Exposure Chamber Proposal Submitted ?/09

Validation Study, Part 1
Investigators and Goals

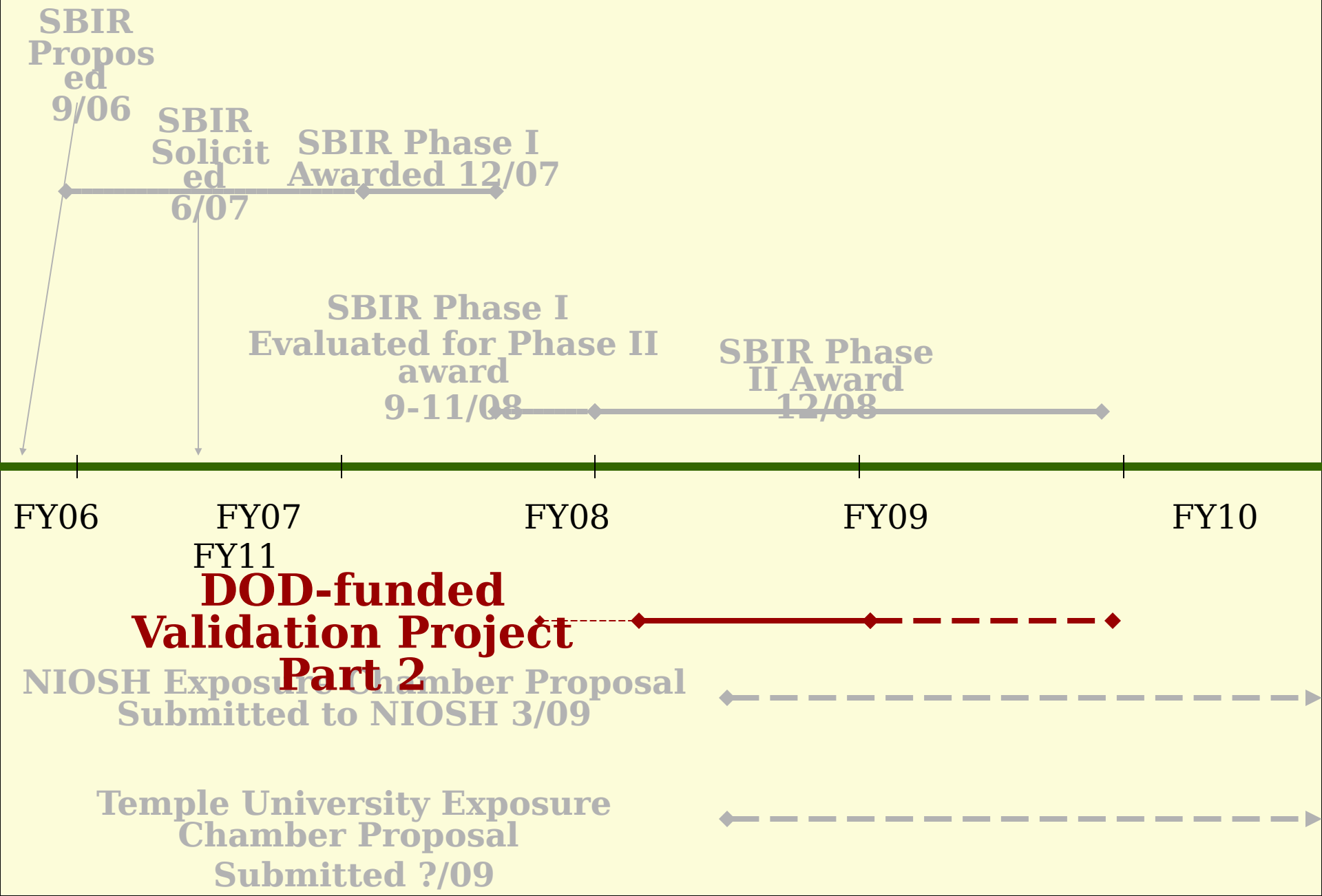
- **Rominder Suri, PhD, Temple University, Civil & Environmental Engineering**
  - Independently validate prototype dosimeter performance: Sensitivity & Selectivity,
  - Define performance environmental parameter: Temperature, Humidity, Dust
  - DOD is the customer.
- **John Snawder, PhD, DABT, Biomonitoring Team, submitted a proposal**
  - The Commercial Transportation Sector is the customer, i.e., NIOSH-Funded.

Topic #3

The Naphthalene Dosimeter Validation

Part 1
Independently validate the performance

Part 2
Transform a prototype exposure monitor into a dosimeter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FY06
FY07
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FY09
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FY11
DOD-funded Validation Project Part 2
NIOSH Exposure Chamber Proposal Submitted to NIOSH 3/09
Temple University Exposure Chamber Proposal Submitted ?/09

Validation: Naphthalene Biomarkers

Funding from the CMRM Directorate, OSD/OUSD (I&E)

- $110,000, contract awarded to Army Research Office for FY09
  - Develop Protocol, Institutional Review Board Approval, Recruit Fuel Handlers

Principal Investigator

- Janis Hulla PhD, DABT, Toxicologist,
  Army Corps of Engineers-SPK

Co-Principal Investigators

- John Snawder, PhD, DABT
  - NIOSH, Biomonitoring Team Leader
- Susan Proctor, DSc
  - Epidemiologist, Army Research Institute of Environmental Medicine
- Micheline Strand, PhD: Project Management
  - Life Sciences Division Chief, Army Research Office

Others Involved with the Validation Project

- **CMRM Directorate, Project Manager**
  - Paul Yaroschak, PE, Deputy Director
- **The CDC Foundation**
- **Allan Buckpitt, PhD, UC-Davis**
  - Collaborating Scientist in FY10
    - » Urine Metabolites/Adducts, Nasal Epithelium Adducts, P450 Activity and/or Expression

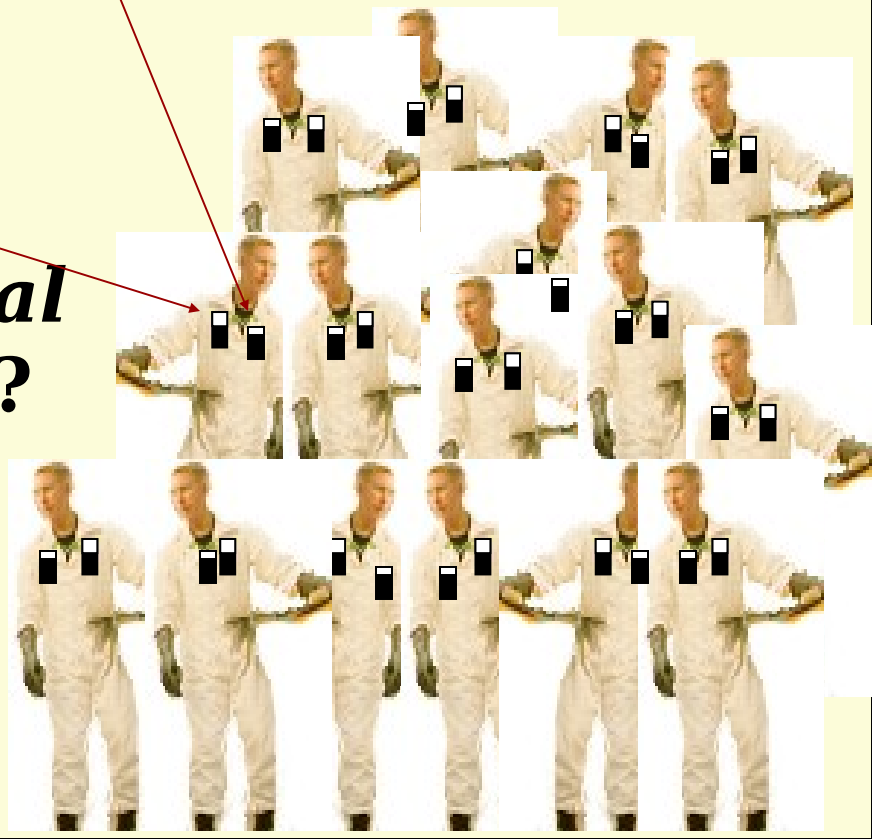
Field Validation

of the prototype exposure monitor

Naph. mg/m³ Conventional ?

Naph. mg/m³ Prototype

How does the *new* technology compare to *conventional* technology?



First Goal to be realized:

Assurance of occupational health protection.

Risk Management Options

- RDT&E
- Material substitution
- Process changes
- Regulatory engagement
- Stockpile material
- Exposure assessment & monitoring
- Personal Protective Equipment (PPE)
- Acquisition changes
- Benchmark with industry
- Risk communication
- Training

Naphthalene Dosimeter SBIR

The 1St Prototype is an *Exposure Monitor*.

Here's how we're going to make it into a *dosimeter*:

A DOD-Funded project that correlates environmental exposure with human biomarkers of exposure.

Naph. Biomarkers

F(x): Naphthalene exposure biomarkers to [Naph. in Air]?

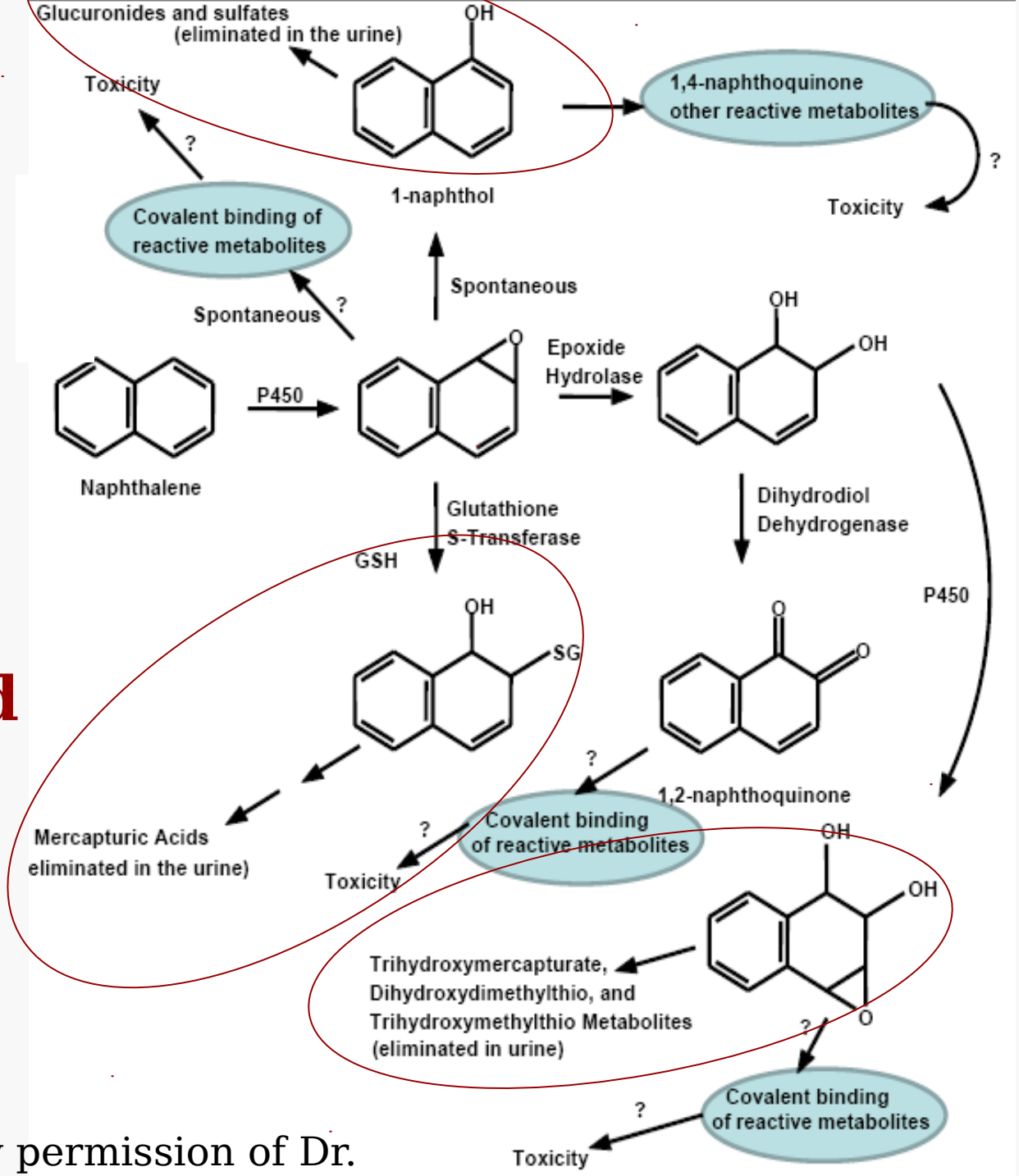
Naph. mg/m³ (Prototype)

Making it a *Dosimeter*

Making it a *Dosimeter*

Urine metabolite/adduct biomarkers will inform:

1. PBPK models

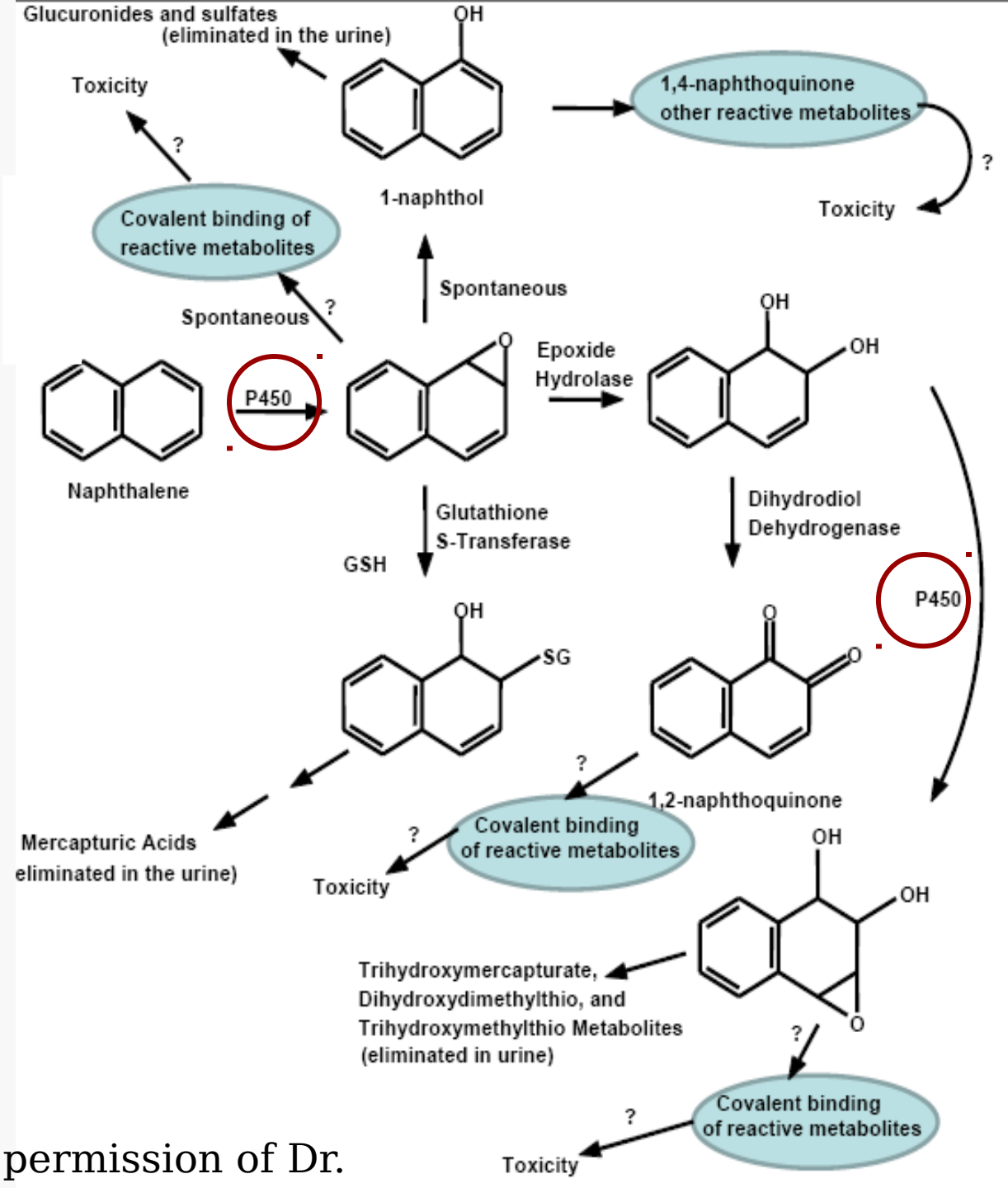


By permission of Dr.

Making it a *Dosimeter*

Enzyme activity, expression (& adduct) biomarkers will inform:

1. PBPK models
2. Mode of Action
3. Biologically Based Dose-

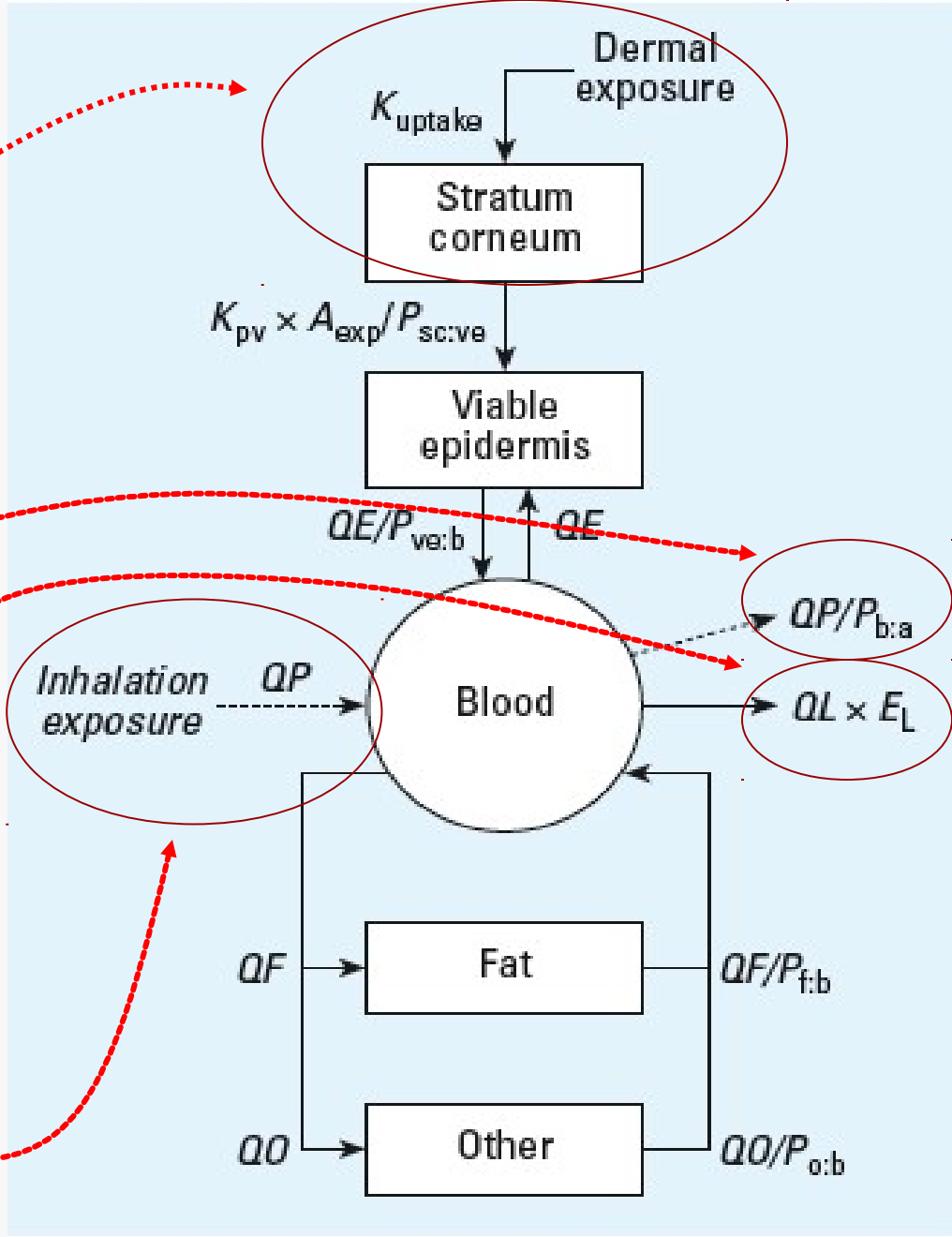


By permission of Dr.

Making it a *Dosimeter*

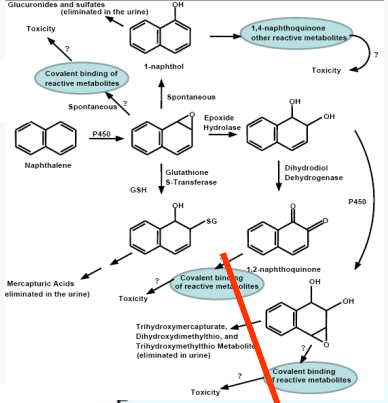
Dermal, Exhaled Air & Urine Metabolite/Adduct analytical data will inform the PBPK & BBDR Models.

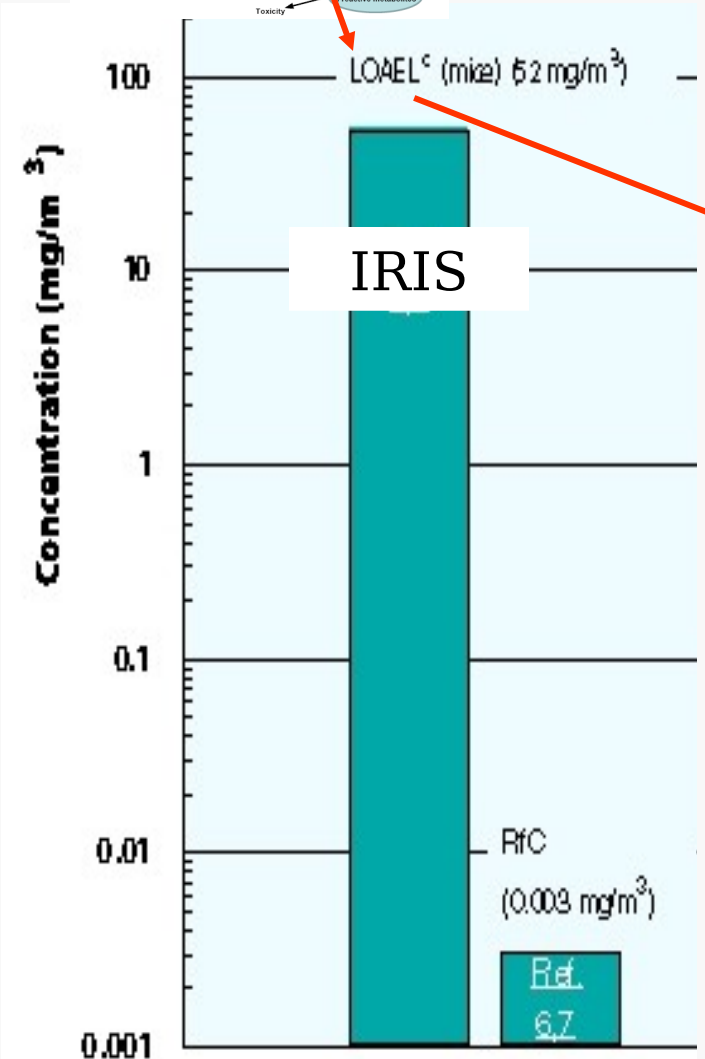
Prototype Dosimeter Data



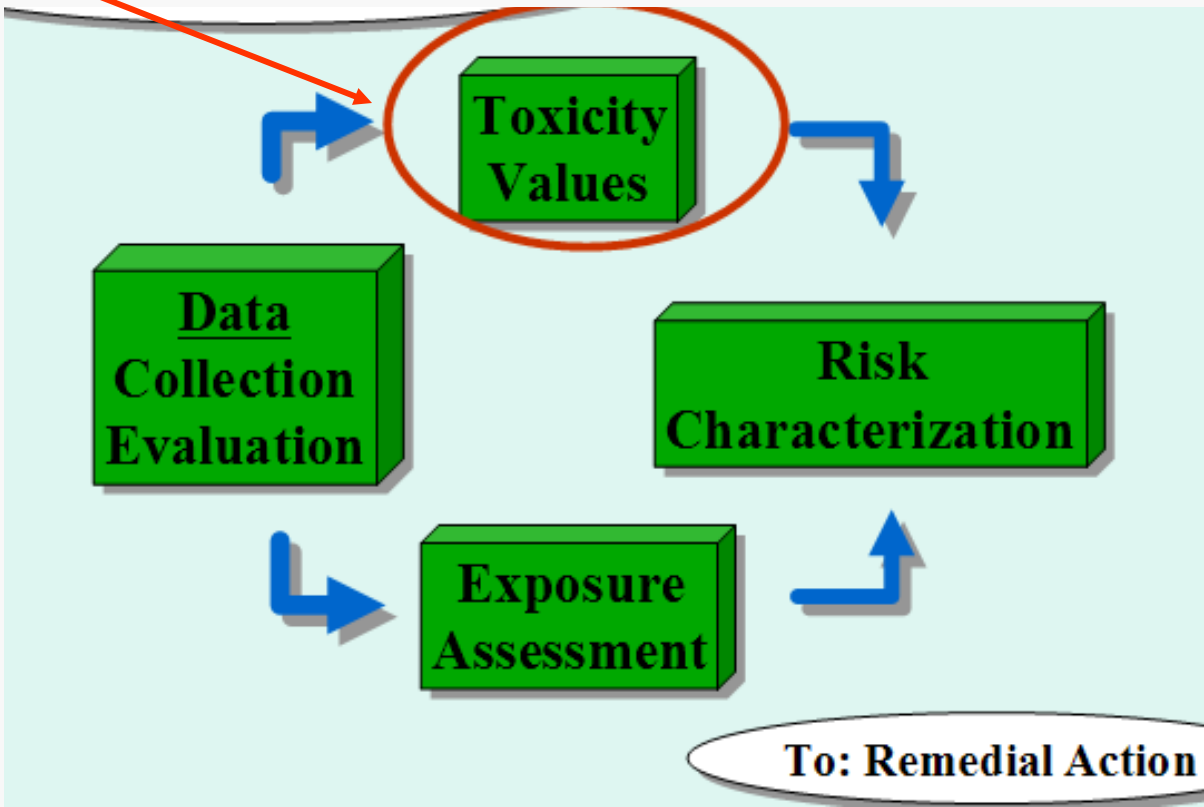
From: Env Health Perspect, Vol 115, No 6, June 2007, PBTK Modeling Demonstrates Contribution of Dermal and Inhalation Exposure Components to End-Exhaled Breath Concentrations

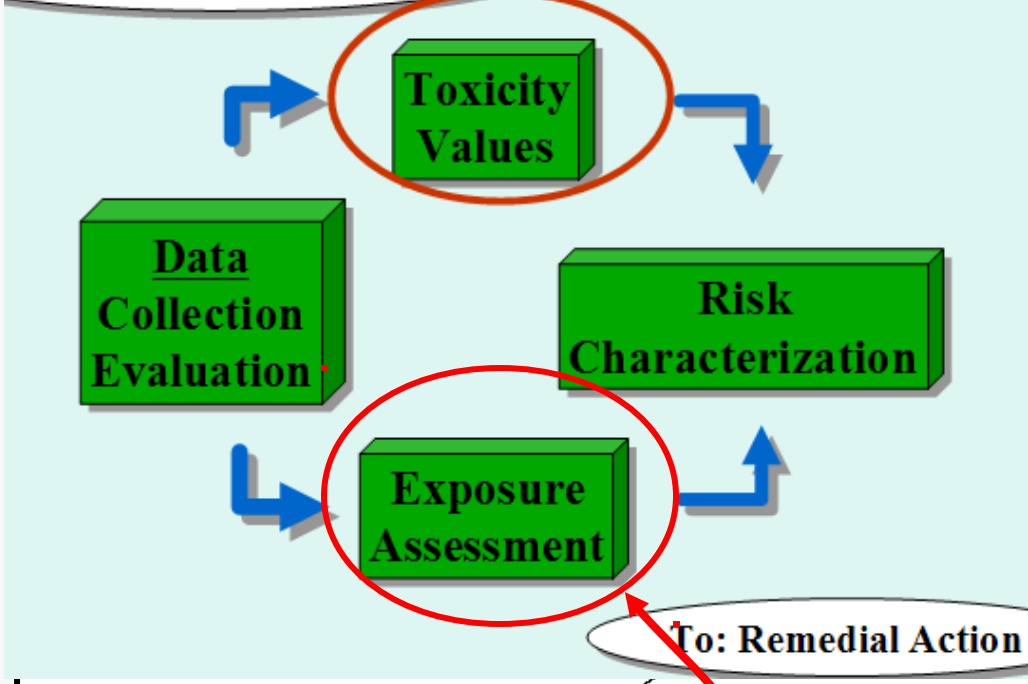
2nd Goal to be realized: Address Risks to Cleanup programs





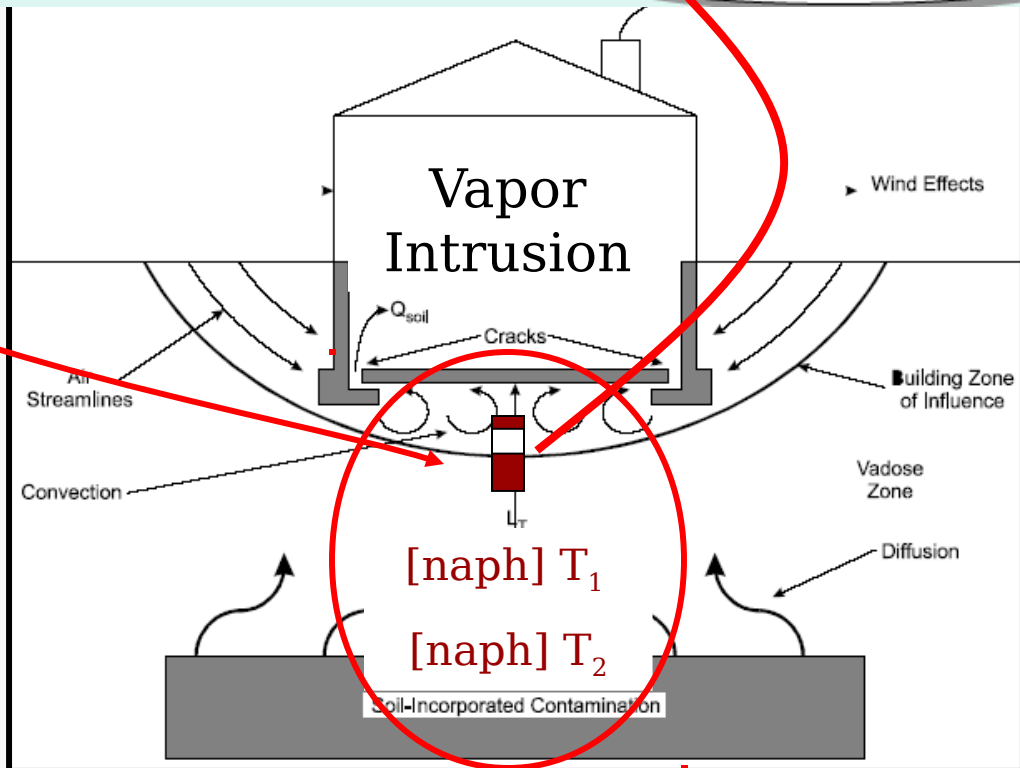
IRIS





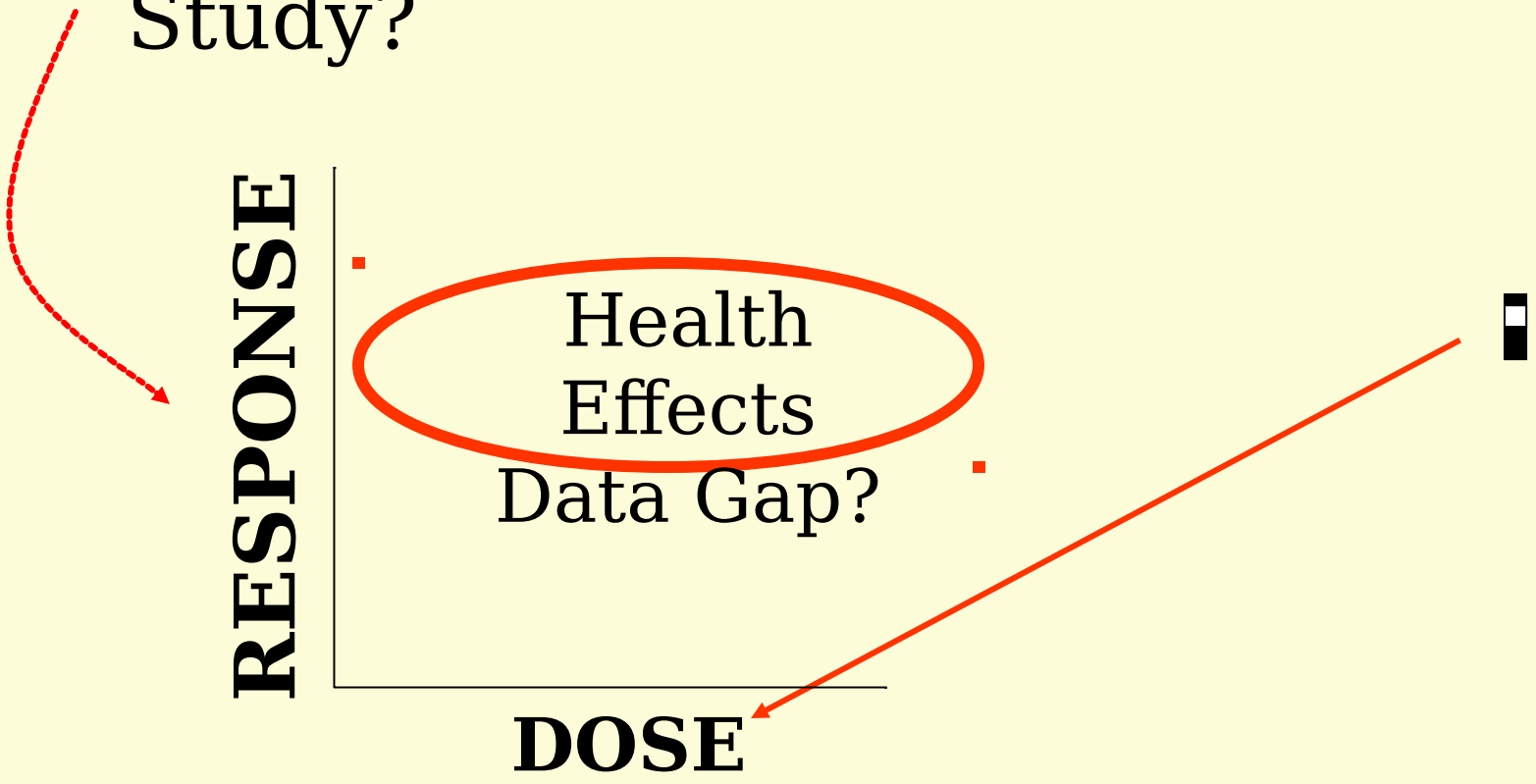
Potential Future Direction: Cleanup

Apply the naphthalene sensor to measure flux across the vadose

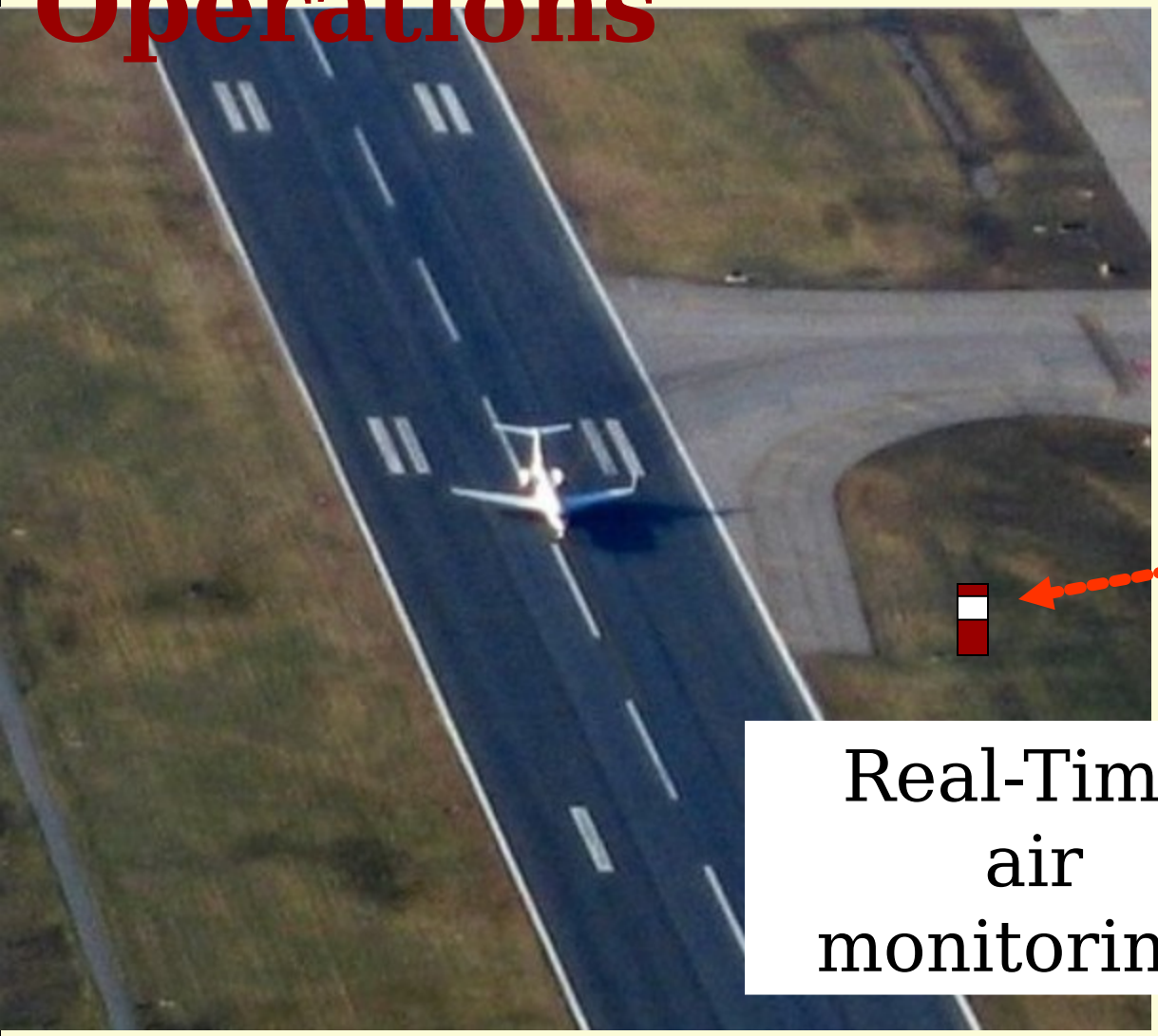


Potential Future Direction: ESOH

Epidemiology Study?



Potential Future Direction: Operations



Real-Time air monitoring?

Concluding..

Thank you for your kind attention.

May I address your questions?

Special Thanks to these Impact Assessment contributors:
US Army Center for Health Promotion & Preventive Medicine, Noblis Inc., Booze-Allan Hamilton, Concurrent Technologies Corp.